"AI CAN BE ANALOGOUS TO STEAM POWER"

or From the "Post-Industrial Society" To the "Fourth Industrial Revolution":

An Intellectual History of Artificial Intelligence

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This article provides an intellectual history of artificial intelligence in the electronic era of computing, that is, from the postwar decades to the present. We argue for the existence of two periods; a first period, defined by the discourse of a post-industrial society and an information age, and a second one, characterised by the discourse of a fourth industrial revolution. Discourses of a post-industrial society and a fourth industrial revolution are constitutively related to discourses of computer automation, which, in turn, are defined by artificial intelligence. This paper provides a canvas of an intellectual history of artificial intelligence in the electronic era through the examination of discourses of this period on computer automation.

Introduction

This article provides an intellectual history of artificial intelligence in the electronic era of computing, that is, from the postwar decades to the present. We argue for the existence of two periods; a first period, defined by the discourse of a post-industrial society—and associated notions, like, most notably, "information society"—and a second one, defined by the discourse of another, new, fourth industrial revolution.[1] The presence of these two periods has not yet received proper scholarly attention— let alone been explained—and our paper addresses this gap. As we argue, the differences between the two periods are related to a change in discourses on

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[1]   For introductions to the history of the concepts "post-industrial" and "information": Howard Brick, "Optimism of the Mind: Imagining Postindustrial Society in the 1960s and 1970s," *American Quarterly* 44, no. 3 (September 1992): 348–80; "Optimism of the Mind"; Kline, "Cybernetics." For one of the first uses of the notion of the fourth industrial revolution: Klaus Schwab, "The Fourth Industrial Revolution: What It Means and How to Respond," *Foreign Affairs*, December 2015.

computer automation.[2] Given that artificial intelligence—broadly understood—is constitutive of (the practice and the concept of) computer automation, an intellectual history of artificial intelligence is necessary for understanding the transition from discourses on a post-industrial society to discourses on a new industrial revolution. Thus, the aim of this article is to provide a canvas of an intellectual history of artificial intelligence through the examination of discourses on computer automation in the last sixty years.

In what follows, we first offer a recontextualisation of the history of artificial intelligence in the electronic era. We then present the historiographical considerations that underpin our historical argument, we embed the history of the electronic era of computing in the history of modernity, and we introduce the material we used. We finally present our historical account proper, analysing the discourses of the two aforementioned periods of the electronic era.

Recontextualising the History of Artificial Intelligence in the Electronic Era

The history of the electronic era can be divided into two relatively distinct periods. The first period spans from the postwar decades to the 1980s; the second one from the 1990s onwards. This periodisation is underpinned by two sets of differences; differences in the *materialities* of artificial intelligence, and in the *discourses* regarding social and normative issues associated with them.

Regarding *materialities*, the first period is defined by the introduction of "mainframe" computers and, later, "microcomputers" ("home" and "personal computers"). The second is defined by the dramatic expansion of computer use and simultaneous interconnections that resulted and is manifested in the "internet", the "web", and various social media. In the first period, the concept of "artificial intelligence" was shaped by the presentation of specific computers as "intelligent," "thinking," and "brainy."[3] In the second, while computers are still described as "intelligent," artificial intelligence is also defined by the generalized production of "data"—that by now have become and are called "big"—being fed into (no longer strictly mathematical) algorithms.[4]

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2   From the rich literature on the history of the relation between automation and work, we may single out Noble, *Forces of Production*, as it pioneered a critical emphasis on the mismatch between the rhetoric and the realities of digitalisation.

3   For histories of presenting computers as intelligent during this period: Natale and Ballatore, "Imagining the Thinking Machine"; Martin, "Myth of the Awesome Thinking Machine."

4   For a sample from critical historiographies of the emergence of big data: Strasser and Edwards, "Big Data Is the Answer"; Beer, "How Should We Do the History." For the transition from the mathematical to the contemporary notion of an algorithm: Burrell, "How the Machine 'Thinks'."

This periodisation schema captures the peculiarity of contemporary artificial intelligence. It accommodates Garvey's observation that while "this is, once again, the Age of Artificial Intelligence," this time artificial intelligence emerges as "an epochal technology now colonizing an increasing number of domains", so that "may soon become ubiquitous, coextensive with technological civilization itself: a taken-for-granted feature of modernity like running water or electricity."[5] In that sense, the notion of intelligence is modified; it ceases being the property of a single machine, and becomes diffused to a network of interrelated machines. As Halpern, Mitchell, and Geoghegan have pointed out, this is manifested in the contrast between a "Cold War rationality," which "emanated primarily from the conceptual publications of a handful of well-funded think tanks," and the prevalence of a "smartness mandate" that "pervades" everything, from cell phones and delivery trucks to health care systems, while relying "intrinsically on the interactions among, and the individual idiosyncrasies of, millions or even billions of individuals around the planet."[6]

These two periods are further defined by a change at the level of *discourses*, which are the subject of this article. This article will not focus on the different materialities of these two periods, but on their differing discourses. In the first period, the public discussion of artificial intelligence focuses more on broader social issues in which the one of computer-based work and employment is central. In the second period, this issue becomes marginalised by discussions of ethical issues regarding artificial intelligence—now known as "AI ethics." Furthermore, in the first period, discourses are centred, more or less explicitly, around the notion of a post-industrial society, while in the second, we encounter discourses on an "artificial intelligence revolution," and its conceptualisation in terms of a new, fourth industrial revolution. Thus, in the first period, the concerns about the future of work were addressed by the emergence of a periodisation schema that argued for a passage to a "post-industrial order" and an "information society."[7] In contrast, the second period brought back the notion of industrialisation: it talked about a fourth, industrial revolution.

This understanding of the history of artificial intelligence in the electronic era brings up both the differences from and the similarities to the history of computing in the mechanical and electronic eras. As we have shown, before it became electronic,

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5   Garvey, "Unsavory Medicine," 1.

6   Halpern, Mitchell, and Geoghegan, "Smartness Mandate," 110.

7   Brick, "Optimism of the Mind"; Kline, "Cybernetics." For Castell's equivalent notions of "network society" (Castells, *Rise of the Network Society*) and "network state" (Castells, *Power of Identity*); "informational society," "informational economy," "informationalism," "information technology revolution," and "information technology paradigm" (Castells, *Rise of the Network Society*); "information age," "informational politics," and "informational democracy" (Castells, *Power of Identity*).

artificial intelligence was mechanical and electrical.[8] For example, the "calculating boards," "artificial lines," and "network analysers," that is, the state of the art computers of the interwar period, were conceptualised as thinking machines.[9]

Moreover, the notion of artificial intelligence is present from the beginning of industrial revolutions. Namely, the presentation of computing tools and machines—ranging from humble computing graphs and slide rules to impressive mechanical and electrical analysers—as intelligent is associated with their presentation as indispensable for the emergence and advance of the first (steam) and the second (electricity) industrial revolution. In this context, the notion of artificial intelligence is associated with a devaluation of human intelligence, that is, of human labour. Presenting computing machines as intelligent was identified with a gendered presentation of computing labour as unintelligent, unskilful, dispensable, subject to replacement by machines. Accordingly, those working with the machines were conceptualised as unskilled machine "attendants," "keepers," and "operators."[10] As Jones-Imhotep has argued in his history of automata and robots, "seeing machines as autonomous, then, has historically meant *not* seeing certain kinds of labor and the people performing it."[11] Thus, keeping the long-run history of computers in mind, we can understand why artificial intelligence in the electronic era was associated, initially, with discourses on a transition to a postindustrial and information society—that is, a break from the mechanical and electrical revolutions. It was only later that discourses on a new industrial revolution cancelled this very break. This discussion is mapped in the following figure (figure 1).

The above shows why the more complex historical picture we provide revises the standard, internalist histories. First, for the available periodisations of the history of artificial intelligence, the differences at the level of materialities are absent; the change from mainframes and minicomputers to the computer networks of the more recent past is neglected. Moreover, regarding what interests us here, these periodisations do not take into account the parallel transition at the level of discourses, that is, the transition from the initial association of artificial intelligence with a postindustrial society to a return to approaching it in terms of another industrial regime.

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8   For a history of presenting computers as intelligent before the 1960s: Tympas, *Calculation and Computation*; Jones, *Reckoning with Matter*; and Mindell, *Between Human and Machine*. On the broader context of this presentation: Daston, "Calculation and the Division of Labor"; Schaffer, "Ok Computer."

9   Tympas, "From Digital to Analog and Back."

10   Tympas, *Calculation and Computation*. Also Daston, "Calculation and the Division of Labor"; Schaffer, "Ok Computer." For the association of the devaluation of computing labour with the gendered character of displaying and concealing different parts of the machine, and, further, the association of the masculine/feminine distinction with the digital/analog demarcation: Tympas, "From the Display."

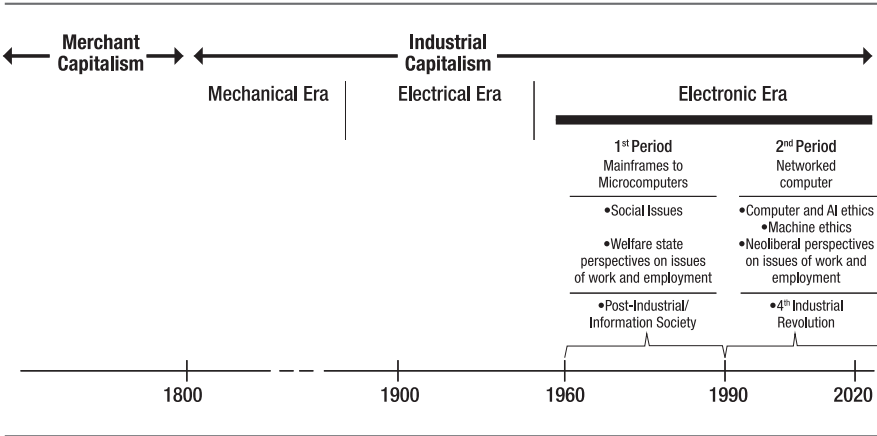11   Jones-Imhotep, "Ghost Factories," 10, emphasis in the original.

Figure 1. Periodisation of the history of artificial intelligence.

This, for example, seems to be the case with the popular periodisation of history of artificial intelligence that stays at three "AI springs" and "AI winters". While proposing to move beyond this internalist historiography of artificial intelligence by paying attention to both the promoters and the discontents of artificial intelligence,[12] Garvey does not complete the break with an internalist stance. By not providing a periodisation that accommodates the above complexities, "AI winters" are conceptualised in terms of some inability of artificial intelligence *itself* to fulfil what various discourses promised about it.[13] Thus, our understanding of artificial intelligence technologies as historically differentiated clusters of *materialities* and *discourses* defining two distinct periods debunks the essentialist foundations of the—more prominent in the field—internalist historiography of artificial intelligence, along with the very distinction between internalist and externalist historiography *tout court*.[14]

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12   Garvey, "Unsavory Medicine," 3.

13   Garvey, "Broken Promises and Empty Threats."

14   Strictly speaking, an internalist approach does not *necessarily* entail a metaphysical position and vice versa. However, such a correlation is strong, and more often than not, internalist approaches are grounded in metaphysical conceptions of technology. In general, we think that robust internalist approaches are grounded in such a metaphysical conception. For the grounding of an internalist approach in a metaphysical stance in the case of Ian Hacking's "styles of reasoning": Simos and Arabatzis, "Ian Hacking's Metahistory of Science." For the employment of history of science in philosophy of science: Arabatzis, "What's in It for the Historian of Science?" On the difficulties involved in trying to avoid determinism—a position that can be characterised metaphysical—in historical and sociological accounts of technology: Wyatt, "Technological Determinism Is Dead."

Our primary research material was *Science*, *Nature*, and *Scientific American*—three of the most influential science and engineering news magazines that shape the field of artificial intelligence internationally—and *The New York Times* and *The Guardian*—two of the most influential newspapers in the anglophone world—from the early 1960s until 2020. Specifically, we examined a corpus of around one hundred articles that displayed references and discussions regarding materialities ("mainframes", "computers", "machines", and, also, "robots"), concepts ("machines with human brain", "intelligent machines", "thinking machines", "artificial intelligence"), and discourses related to computer automation, computer and artificial intelligence ethics, and the wider social dimensions of the above. Our references in the next section cover about the one third of the examined material.

As we provide an intellectual history of artificial intelligence, our primary focus will be on public discourses. In that sense, we run together several interrelated insights. To start with, we do not assume an essentialist distinction between world and language, which, tacitly and more often than not, underpins internalist histories of technology. On the contrary, we consider our linguistic practices as formative and, in fact, constitutive of the very reality we talk about. Our discourses do not merely represent the things they describe; they shape and fashion them accordingly. In the case of technology this can be understood in terms of a feedback loop. As Carbonell, Sánchez-Esguevillas, and Carro astutely summarise their inquiry on technological metaphors,

> metaphors work as a kind of framework that allows a two way process: technologies are characterized based on metaphors taken from the reality of the daily life and these metaphors shape the evolution and the perception of this reality. . . . [M]etaphors act as a framework that ease the interaction in a double way, not only helping to define an emerging technology in terms of a reality but also impacting in the evolution and perception of reality.[15]

Or, as Rauscher puts it starkly, in her analysis of discourses on automation and platform economy in the context of the issue of the future of work in the United States, "discourses do not only contribute to behavior; they *are* human behavior in itself."[16]

Shiller's claim that "the *narratives themselves* have the potential to drive amplified economic booms and recessions, as well as public policy"[17] applies to scientists and engineers *salva veritate*: science and engineering news magazines do not (only) map the landscape of artificial intelligence; by doing so, they set the directions for

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15   Carbonell, et al., "Role of Metaphors," 149, 151.

16   Rauscher, *Future of Work*, 2, emphasis not added.

17   Shiller, *Narrative Economics*, 211, quoted in Rauscher, *Future of Work*, 3, emphasis added.

further research.[18] Given the above, our account does not attribute any explanatory priority to a specific ontological category (materialities or discourses). We rather seek to show how the specific discourses are clustered in two periods, and, thus, to indicate their association with the materialities mentioned above.

More specifically, we approach the discourses on computer automation according to three basic axes. The first axis concerns the relation between computer automation and *well-being*. It involves the discussion of issues of job satisfaction, work meaningfulness, alienation, and leisure, and others directly associated with them. The second axis concerns the *future of employment*. It involves the discussion of displacement, unemployment, and "creative destruction."[19] The third axis concerns the *framework* within which the discussion of the above takes place. It constitutes the description and evaluation of the power structures regarding work, and can range from a non-discussion of the issue (and cursory or platitudinous remarks), to the suggestion of specific measures or radical changes.[20]

An Intellectual History of Artificial Intelligence in the Electronic Era

As indicated above, the first period that we describe in the electronic era spans from the early 1960s to the late 1980s. In this period, the prevailing—either explicitly used or analytically implied—notion was that of a post-industrial society. We see the use

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18   For similar approaches: Natale and Ballatore, "Imagining the Thinking Machine"; Roberge, et al., "How to Translate Artificial Intelligence?" Also Watson, "Rhetoric and Reality of Anthropomorphism." For similar accounts of the representation of artificial intelligence in newspapers: Ethan Fast and Eric Horvitz, "Long-Term Trends in the Public Perception of Artificial Intelligence," in *AAAI'17: Proceedings of the Thirty-First AAAI Conference on Artificial Intelligence,* February 2017, 963–69; Ching-Hua Chuan, Wan-Hsiu Sunny Tsai, and Su Yeon Cho, "Framing Artificial Intelligence in American Newspapers," in *AIES '19: Proceedings of the 2019 AAAI/ACM Conference on AI, Ethics, and Society,* January 2019, 339–44; Sun, et al., "Newspaper Coverage." Also Vlantoni and Papanastasiou, "Live from the womb." For a long history of the narratives regarding artificial intelligence: Cave, et al., *AI Narratives.*

19   The notion is Schumpeter's (Schumpeter, *Capitalism, Socialism and Democracy*, ch. 7) and describes a classical political economy topos. Its implication, very roughly put, is that the number of created jobs will be eventually relatively sufficient to absorb the displaced workforce.

20   The selection of the specific axes can be understood as a rather loose employment of Michel Foucault's notion of *problematisation* (Foucault, "Le souci de la vérité," 1489). Furthermore, the employment of the notion of a power structure—defined as a temporal coagulated configuration of a set of power relations—aspires to be opposed to abstract moral theorising, and to designate a contextualist approach. See Geuss, *Philosophy and Real Politics*; Foucault, *Histoire de la sexualité*; Michel Foucault, "*Il faut défendre la société.*"

of the notion of "leisure revolution",[21] and, more importantly, "information age,"[22] suggesting a break from the industrial period, and a different work regime. This period is characterised by three main trends. The first follows a post-industrial schema. The second elaborates on the political framework within which a post-industrial society could be sustained. The third trend records a disillusionment with the post-industrial schema.

The second period under consideration spans from the 1990s to the present. By the 2010s we clearly observe the configuration of two trends in the discussions of the relation between computer automation and work. The first, most dominant trend instantiates the approach of this relation from a largely neoliberal perspective. The second trend instantiates a neo-liberal critique.[23] The configuration of these two trends coincides with the emergence of discussions of an artificial intelligence revolution, itself conceptualised as a new, fourth industrial revolution. Central to these developments is the gradual replacement of the discussion of social issues regarding computer automation by the discussion of artificial intelligence ethics—now known as "AI ethics."[24]

"What Counts is Information:" The Discourse of a Post-industrial Society

The discourses on artificial intelligence in the first period are centred around the notion of a post-industrial society.[25] This notion can be understood in terms of two

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21   Peter Large, "Are We Prepared for the New Society That Must Follow When Computers Run Industry?" *The Guardian*, July 18, 1977, 14.

22   Michael L. Dertouzos, "Communications, Computers and Networks," *Scientific American* 265, no. 3 (September 1991): 62–71, *passim*.

23   It is indicative, however, that even more than half of the articles of this third trend are characterised by *epistemic equipollence*: in these cases the critique, however strong, is presented balanced by the opposite stance.

24   Noticeably, in the 1990s and the 2010s, the discussion was, mainly, not about ethical issues regarding machine use—in which issues of work would typically fall—but about "machine ethics." According to Anderson and Anderson, unlike computer ethics, which has traditionally discussed ethical issues "surrounding humans' use of machines," machine ethics is focused upon "ensuring that the behavior of machines toward human users, and perhaps other machines as well, is ethically acceptable." (Michael Anderson and Susan Leigh Anderson, "Machine Ethics: Creating an Ethical Intelligent Agent," *AI Magazine* 28, no. 4 (December 2007): 15–26, 15.) Müller employs the same distinction: Vincent C. Müller, "Ethics of Artificial Intelligence and Robotics," in The Stanford Encyclopedia of Philosophy, Summer 2021 Edition, edited by Edward N. Zalta, accessed March 15, 2022, https://plato.stanford.edu/archives/sum2021/entries/ethics-ai/. Also Serafimova, "Whose Morality? Which Rationality?")

25   For the development and the influential power of Daniel Bell's concept in this era: Waters, *Daniel Bell*, 105. Bell was a household name at the time, cutting across different cultural areas. (Wade, "Daniel Bell.")

principal dimensions: "the change from a goods-producing to a service economy" and "the pre-eminence of the professional and technical class."[26] Thus, "a post-industrial society is based on services. . . . What counts is not raw muscle power, or energy; what counts is *information*."[27] This entails two ideas: the *eradication of class conflicts*,[28] and the *presence of a solid political structure* that could handle the transition costs, and, more importantly, guarantee the sustainability of a post-industrial society. [29]

The first trend in the period's discourses employs the notion of a post-industrial society, and, without, though, elaborating much on its premises, focuses on the issue of well-being. The "information infrastructure" is what guarantees "job satisfaction", improvement of life, and more freedoms.[30] The second trend touches on well-being, but, more importantly elaborates on the political structure that would sustain a post-industrial society. As early as 1963, it is argued that

> [w]hen you think of combining these three features—computer planning, automatic machines and a flexible conveyor system—into a single unity, you are beginning to get a glimpse of the automatic factory. . . . It would be a factory without direct labour, and, most important without any repetition work. In it, or around it, there would only be people whose work is creative . . . . This is still in the future, but it is not Utopia. . . . [W]e can look forward to a world in which everybody has a job worth doing and the standard of living has risen to such heights that we may all be living like lords on a 15-hour working week.[31]

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26 Bell, *Coming of Post-Industrial Society,* Introduction, *passim.*

27 Daniel Bell, "The Coming of the Post-Industrial Society," *The Educational Forum* 40, no. 4 (May 1976): 576, emphasis added.

28 Wade, "Daniel Bell" and Bell, "Coming of the Post-Industrial Society," 577, 579. Conflicts remain—though much less violent ones—but are mainly transposed among *situses*: "economic enterprises, government bureaus, universities and research complexes, social complexes (e.g., hospitals, social-service centers), and the military." (Bell, *Coming of Post-Industrial Society*, Forward, *passim.*)

29 Bell is at pains not to provide a more substantial description of it; "any picture of its [sc. post-industrial society's] impacts necessarily has to be conjectural." (Bell, "Coming of the Post-Industrial Society," 578–79.)

30 For example: "Scientists Define Technology's Aims," *The New York Times*, October 30, 1966; Hudson, "Computers in Manufacturing," 824; Vincent E. Giuliano, "The Mechanization of Office Work," *Scientific American* 247, no. 3, (September 1982): 148–65, 163; and Dertouzos, "Communications, Computers and Networks," *passim*. It has to be noted, though, that after the 1970s and into the start of the 1980s, the more these ideas were accompanied —however, tacitly—by the invoking of neoliberal themes. An example that displays political sensibility without assenting—at least explicitly—to the notion of a post-industrial society is Herbert A. Simon's article, published one year before his being awarded with the Nobel prize (Simon, "What Computers Mean for Man and Society").

31 Lilley, "Scientific Revolution and Industrial Processes," 1134, 1137.

However, in order to avoid "automation causing unemployment … radical changes in our society and our economy" are needed:

> the unemployment problem . . . is inherent in the nature of a capitalist economy and cannot be solved within that framework, but does not arise in a socialist economy; . . . socialism is inherently capable of doing a better educational job than capitalism . . . I do not want to argue the point now, though I shall not attempt to conceal the fact that I am one of those who do think that automation can only prosper under socialism.[32]

The selfsame structure of coupling the possibility of well-being with the suggestion of a radical framework is found again some years later in an examination of the case of Sweden where "the post-industrial society has arrived . . . with a bang."[33] Namely, "Swedes no longer regard an increase in their standard of living as their first objective. Rather, they are concerned with improving the quality of life—*seeking greater work satisfaction and more leisure*."[34] The "immediate" problem that the increasing shrinking of the workforce creates, is presented by the discourses of this trend in the form of a clean-cut dilemma regarding two ways forward: "Toward profit-sharing, which essentially teams up the interests of workers with those of management? Or toward market control, meaning a fundamental shift of power from management to labour?"[35] The article then proposes a radical solution in order to enable the second.[36]

Finally, the third trend in the articles of this period exhibits a disillusionment with the post-industrial. In short, the framework of post-industrial society is usually tacitly assumed or explicitly invoked, yet the primacy of information and knowledge over production of goods, and the consequent eradication of class conflict are challenged. According to Birnbaum's triple book review, Howe's anthology *The World of the Blue-Collar Worker* challenges "Bell's . . . assertion that a class politics has ended," while Sheppard and Herrick's *Where Have All the Robots Gone?* gives voice to the assembly line workers: "They do not like their work, and are dissatisfied with much else in their lives. . . . At any rate, they do show that the problems of class society, and of working class, are apparently with us again."[37] In the last years of the

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32   Lilley, "Scientific Revolution and Industrial Processes," 1135, 1137.

33   Leonard Silk, "Post-Industrial Capitalism," *The New York Times*, 13 June 1976, 115.

34   Silk, "Post-Industrial Capitalism," 123, emphasis added.

35   Silk, "Post-Industrial Capitalism," 115.

36   Not only is it indicative that a socialist solution is discussed as a viable option, but the dilemma of the Swedish industry itself is between two socialist variations.

37   Norman Birnbaum, "The Working Class Is Still with Us," *The New York Times*, November 26, 1972, 195. Also Stephen Wood, "It's Time We Bought Ourselves a Central Nervous System," *The Guardian*, June 2, 1989.

1980s, this disillusionment appears more forcefully. In the words of an eloquent 1989 *New York Times* article title, "The Post-Industrial Era Is Over."[38] Similarly, another article argues,

> Of course, things have changed. Production work has changed. People go home cleaner; more and more of them leave offices rather than factories. Service activities have proliferated. The division of labor has become infinitely more elaborate. But the key generator of wealth for this vastly expanded and differentiated division of labor remains mastery and control of production. *We are not experiencing a transition to a post-industrial society, but from one kind of industrial society to another.*[39]

The primacy of the production of goods (as opposed to information) and the issue of class conflict are (re)affirmed.

AI Can Be Analogous to Steam Power": The Discourse of an Artificial Intelligence Revolution as A New Industrial Revolution

The emergence of discussions of an artificial intelligence revolution, itself conceptualised as a new, fourth industrial revolution, coincides with the configuration of two trends in the discussions of the relation between computer automation and work. [40] The first, most dominant trend instantiates the approach of the issue from a neoliberal perspective, while the second, underrepresented one instantiates an antineoliberal critique.

The notion of neoliberalism can be said to largely describe "the philosophical view that a society's political and economic institutions should be robustly liberal and capitalist, but supplemented by a constitutionally limited democracy and a modest welfare state."[41] Furthermore, a central value of neoliberalism is individual well-being, resulting from a largely unhindered exercise of (equally individual) freedom. This entails an antipaternalist stance in matters political, economic, and cultural.[42]

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38   Lester C. Thurow, "The Post-Industrial Era Is Over," *The New York Times*, September 4, 1989, 27.

39   Stephen S. Cohen and John Zysman, "Can Services Survive without Manufactoring?; The Myth of a Post-Industrial Economy," *The New York Times*, May 17, 1987, 143, emphasis added. The exact same argument is raised in Peter Large, "Frontiers of Work," *The Guardian*, June 2, 1989, 14.

40   In terms of Halpern, Mitchel, and Geoghegan's astute description, this is the period of the "smartness mandate" (Halpern et al., "Smartness Mandate").

41   Kevin Vallier, "Neoliberalism," in *Stanford Encyclopedia of Philosophy*, Summer 2021 Edition, ed. Edward N. Zalta, https://plato.stanford.edu/ entries/neoliberalism/.

42   Geuss, "Can the Humanities Survive Neoliberalism?," 154, and *passim*. Also Geuss, "Economies: Good, Bad, Indifferent"; Geuss, *Philosopher Looks at Work*.

The neoliberal trend in the articles of this period is characterised by three themes. The first one is an explicit endorsement of the classical political economy topos of *creative destruction*—apparent in almost all articles of this trend. This idea summarises the circular function of the capitalist doctrine. Roughly put, new forms of industrial production destroy previous economic structures, while creating new ones, and, thus, the created new jobs will balance out the ones lost.[43] In these articles, this idea is accompanied by the tacit suggestion that growth is of workers' profit and well-being. However, something that these articles do not address is that the elimination of the unemployment threat does not guarantee the high quality of the jobs created: having a job does not mean having a good job. Thus, in short, the invoking of creative destruction *obliterates* the discussion of the accompanying power structure.[44]

Second, these articles appear to *justify*, in a series of ways, the neoliberal picture adumbrated above. All the articles that invoke the idea of creative destruction *recontextualise* the notion of an artificial intelligence revolution: its differences from the previous industrial revolutions are downplayed, and it is presented as not being any different from the preceding ones; it is another industrial revolution that will be accompanied by the same circle of events. Thus, identifying an artificial intelligence revolution as another industrial one means reducing it to the circular function of capitalism. *Science* was even more explicit, arguing that "*AI can be analogous to steam power*: Steam power helped humans to do manual labor, while AI will help humans to do intellectual labor."[45] An interview in the *New York Times* reported: "'It is literally the story of the economic development of the world over the last 200 years,' said Marc Andreessen, a venture capitalist and an inventor of the web browser. 'Just as most of us today have jobs that weren't even invented 100 years ago, the *same* will be true 100 years from now.'"[46] Another article on the subject observed:

> But history shows that employment usually recovers after a technological revolution—. . . I am optimistic that new jobs will replace the old ones in areas we can't even imagine yet, just as the working world evolved after the Industrial Revolution. We don't blame the steam engine or tractors or sewing

43   Schumpeter, *Capitalism, Socialism and Democracy*, 83, and ch. 7: *passim*.

44   To be sure, the identification of growth with well-being is not part of the notion of creative destruction *simpliciter*, and, of course not, by far, something to which Schumpeter would subscribe.

45   Levine, "Not Just for Bots," 1072, emphasis added. Also Alex Williams, "Will Robots Take Our Children's Jobs?" *The New York Times*, December 11, 2017.

46   Claire Cain Miller, "As Robots Grow Smarter, American Workers Struggle to Keep Up," *The New York Times*, December 15, 2014.

machines for unemployment now. This sounds worrisome only because we can't anticipate the new jobs that these technologies will bring and the new businesses that people will devise, *as they always have*.[47]

Furthermore, these articles invoke the *timeframe* of the development of automation. The pace of the automation process, it is argued, is such that allows the development of the necessary skills.[48] Thus, the new work regime becomes one of "*symbiotic autonomy*."[49] Human labour is not displaced, as humans will work alongside machines. As one article declared: "Welcome to the era of AI-human hybrid intelligence, where people and artificial intelligence systems work together seamlessly."[50] Moreover, the topos of the inalienable human creativity that creates a new regime and guarantees the worker's irreplaceability and adaptability is invoked by several articles: "There are certain human skills machines will probably never replicate, like *common sense*, *adaptability* and *creativity*, said David Autor, an economist at M.I.T. Even jobs that become automated often require human involvement, like doctors on standby to assist the automated anesthesiologist, called Sedasys,"[51] or "the good news is that there are plenty of 'human' skills that A.I. cannot master: *creativity*, *social interaction*, physically complex or dexterous work and, of course, using the A.I. tools that require human operators,"[52] or "The future's still bright, thanks to our *creativity—our unique trait*."[53]

  And, of course, the link with well-being is next: this regime, in turn, releases the potential for more meaningful, productive, and, again, creative work. Indicatively, the two following quips invoke all the characteristics mentioned so far:

47 Ji Shisan, "The End of Work?" *The New York Times*, December 10, 2015, emphasis added. Also Pedro Domingos, "Artificial Intelligence Will Serve Humans, Not Enslave Them," *Scientific American* (September 2018): 88–93.

48 "Though the AI Revolution is underway, it is unlikely to eliminate many office jobs within the next five to 10 years." (Shisan, "The End of Work?"). Also Steve Lohr, "A.I. Will Transform the Economy. But How Much, and How Soon?" *The New York Times*, November 30, 2017, Domingos, "Artificial Intelligence Will Serve Humans," and Shira Ovide, "We're Still Smarter Than Computers," *The New York Times*, November 25, 2020.

49 John Markoff, "Making Robots More Like Us," *The New York Times*, October 28, 2013, emphasis added. The idea first occurs as early as in 1992: Gary Stix, "No Tipping, Please," *Scientific American* 266, no. 1 (January 1992): 141. The author refers to humans supervising robots. The term "symbiotic autonomy" appears in John Markoff, "Making Robots More Like Us," *The New York Times*, October 28, 2013.

50 Shisan, "The End of Work?"

51 Miller, "As Robots Grow Smarter," emphasis added.

52 Kai-Fu Lee, "Give the A.I. Economy a Human Touch," *The New York Times*, December 10, 2020, emphasis added.

53 Shisan, "The End of Work?," emphasis added.

In addition to making some jobs obsolete, new technologies have also long complemented people's skills and enabled them to be more productive — as the Internet and word processing have for office workers or robotic surgery has for surgeons. … More productive workers, in turn, earn more money and produce goods and services that improve lives.[54]

With more freedom and time in such a new social contract, people will be liberated to follow their passions, creativity and talents, and to let that personal exploration inform their careers as never before.[55]

The final theme is a discussion of the measures needed to fight automation driven unemployment. Retraining and education appear as the dominant solution. In some rare cases the public sector is invoked. In these cases, the public sector appears either in terms of a vague collaboration with the market, or as tacitly withdrawing. Even one of the most moderate and careful articles is indicative of this trend:

To make use of the new opportunities, people will need radical, lifelong retraining. The AI revolution won't be a single event after which the job market and the educational system will settle into a new equilibrium. Rather, it will be a cascade of ever-bigger disruptions. . . . Creating new jobs might prove easier than retraining people to fill them. A huge useless class might appear, owing to both an absolute lack of jobs and a lack of relevant education and mental flexibility.[56]

The articles that voice an anti-neoliberal critique form a minority. This critique is mapped against the themes above. By raising the issues of massive unemployment and unequal income distribution, these articles stand opposed to the idea of creative destruction, and shift the focus of the discussion to power structures. For example, one article reports that "Lawrence H. Summers, the former Treasury secretary, recently said that he no longer believed that automation would always create new jobs. 'This isn't some hypothetical future possibility,' he said. 'This is something that's emerging before us right now.'"[57] According to another:

54   Miller, "As Robots Grow Smarter," emphasis added.

55   Lee, "Give the A.I. Economy a Human Touch."

56   Harari, "Reboot for the AI Revolution," 325. Also Lee, "Give the A.I. Economy a Human Touch"; Miller, "As Robots Grow Smarter," and Shisan, "The End of Work?." To be sure, Harari does refer to globalized markets, characterised by various forms of inequality—without, though, using this term (Harari, "Reboot for the AI Revolution").

57   Miller, "As Robots Grow Smarter." Also Claire Cain Miller, "The Long-Term Jobs Killer Is Not China. It's Automation," *The New York Times*, December 21, 2016; Scientific American's Board of Editors, "Will Work for Machines," *Scientific American* 311, no. 2 (August 2014): 10.

> The conventional economic wisdom has long been that as long as productivity is increasing, all is well. Technological innovations foster higher productivity, which leads to higher incomes and greater well-being for all. And for most of the 20th century productivity and incomes did rise in parallel. But in recent decades the two began to diverge. Productivity kept increasing while incomes—which is to say, the welfare of individual workers—stagnated or dropped.[58]

The following observation is similarly indicative: "For those who are working, wage growth has been weak, while corporate profits have surged."[59]

Furthermore, the articles attempt to debunk the neoliberal conceptualisation of the current state as another industrial revolution, addressing the substantive problem of the lack of skills. According to an article for example:

> At the same time, the American work force has gained skills at a slower rate than in the past—and at a slower rate than in many other countries. . . . Clearly, many workers feel threatened by technology. In a recent New York Times/CBS News/Kaiser Family Foundation poll of Americans between the ages of 25 and 54 who were not working, 37 percent of those who said they wanted a job said technology was a reason they did not have one. Even more—46 percent— cited "lack of education or skills necessary for the jobs available."[60]

The issue of skills designates a fundamental problem and reveals the power relations at play.[61] As the relevant articles argue, since the skill acquisition rate is slower than the unemployment rate, the education and retraining solution—especially when funded by the private sector—cannot be a viable one. The divide between lower and higher skilled workers gets larger, the demand seems to be almost exclusively for highly skilled workers, while, in turn, the acquisition of higher skills is costly in terms of both money and time. In that sense, the solution of education and retraining entirely overlooks the problem of *access* to education and retraining. And the latter issue depends largely on class.[62]

58   Scientific American's Board of Editors, "Will Work for Machines," 10. Also Steve Lohr, "Don't Fear the Robots, and Other Lessons From a Study of the Digital Economy," *The New York Times*, November 17, 2020.

59   Miller, "As Robots Grow Smarter."

60   Miller, "As Robots Grow Smarter." See also Miller, "The Long-Term Jobs Killer."

61   For history of technology classics on this problem: Braverman, *Labor and Monopoly Capital*; Noble, *Forces of Production*.

62   Interestingly, the notion of class is largely absent from the discourses of this period.

Finally, these articles suggest as a solution a robust public sector,[63] which debunks the idea of a self-regulating market mechanism. In Lawrence H. Summers' words, again, "the answer is not to just suppose that everything's going to be O.K. because the magic of the market will assure that's true."[64]

Conclusion

In this article, we argued for two periods in the history of artificial intelligence. The first period is defined by discourses centred around the notion of a post-industrial society. The second one is defined by discourses centred around the notion of a fourth industrial revolution. These discourses are constitutively related to discourses on computer automation, which, in turn, are defined by artificial intelligence. Thus, we provided an intellectual history of artificial intelligence in the electronic era through the examination of discourses of this period on computer automation. We showed how artificial intelligence technologies understood as clusters of discourses and materialities fall into two distinct historical periods, and we indicated how these two periods are related to the previous mechanical and electrical eras. More specifically, we observed that, in the first period discussions of well-being and employment were constitutively associated with the concern about and elaboration of the political structure that could guarantee and sustain them. In the second period, the relevant discussions were centred around notions of "creative destruction," "creativity," and "retraining," indicating the assent to the current neoliberal regime, and tacitly obliterating discussions about power relations.

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63   Miller, "The Long-Term Jobs Killer Is Not China."
64   Miller, "As Robots Grow Smarter."

Acknowledgments

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